Characterization of Dynamic Thermal Control Schemes and Heat Transfer Pathways for Incorporating Variable Emissivity Electrochromic Materials into a Space Suit Heat Rejection System

Completed Technology Project (2012 - 2016)

Project Introduction

In the not so distant future, manned spaceflight missions will venture further from Earth than ever before. Throughout these missions, preserving consumables vital to crew survival will become increasingly important. The space suit thermal rejection system is one particularly wasteful user of water. The current thermal rejection system utilizes a water sublimator as the primary means of heat rejection. While future systems are envisioned to utilize water sublimation for suit heat rejection. Neither of these mechanisms have the potential to reduce impacts of extravehicular activities on water mass required to achieve mission objectives. One potential means of reducing spacewalk impacts on water mass is the incorporation of electrochromic radiators to space suit outer surfaces. Electrochromics are variable emissivity materials capable of regulating radiation heat transport and maintaining thermal equilibrium. A prior study demonstrated first order feasibility of electrochromic implementation for lunar surface extravehicular activities. Results showed that sublimator water consumption would have been reduced by ~69% across the entire Apollo program, corresponding to a savings of ~68.5 kg of mass delivered to the lunar surface. The technology readiness level (TRL) of electrochromic radiators implemented into space suit surfaces was a 3/4 at the end of those investigations. The goals of this proposal for the NASA Space Technology Research Fellowship are to characterize dynamic performance and control of electrochromic radiators at a breadboard level in both bench top and thermal vacuum environments, and to investigate heat transfer pathways from the skin to the external environment. At the conclusion of this research variable emissivity radiators in space suit thermal systems are expected to reach a TRL-4/5, putting them in line with the NASA stated goal of completing TRL-6 demos of closed-loop heat rejection system components by 2020.

Anticipated Benefits

The incorporation of electrochromic radiators to space suit outer surfaces represents one potential means of reducing spacewalk impacts on water mass.

Project Image Characterization of Dynamic Thermal Control Schemes and Heat Transfer Pathways for Incorporating Variable Emissivity Electrochromic Materials into a Space Suit Heat Rejection System

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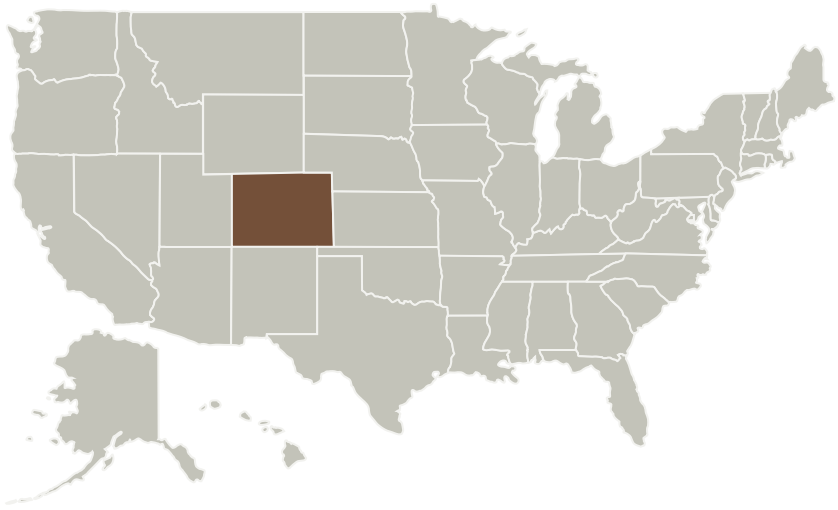
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Colorado Boulder	Supporting Organization	Academia	Boulder, Colorado

Primary U.S. Work Locations
Colorado

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

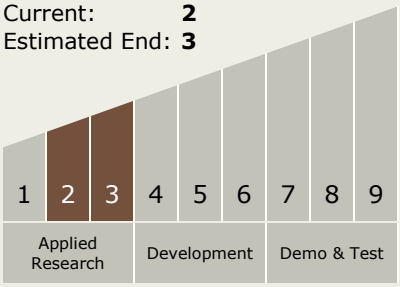
David Klaus

Co-Investigator:

Christopher J Massina

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



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Images

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Project Image Characterization of Dynamic Thermal Control Schemes and Heat Transfer Pathways for Incorporating Variable Emissivity Electrochromic Materials into a Space Suit Heat Rejection System *(https://techport.nasa.gov/image/1727)*

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.2 Thermal Control Components and Systems
    - TX14.2.3 Heat Rejection and Storage